



Building Material

Have you ever thought how buildings are made and what are the different components of a building. You must have seen different building materials near a construction site. Buildings are made of various type of material. Do you know that in the total expenditure in the construction of a structure, the building material share around 60–65 per cent cost. We will now try to familiarise ourselves with different building material as well as their composition.

Important building material used in construction are:

- (i) Stones
- (ii) Clay Products (Bricks, Tiles and Terracotta)
- (iii) Cement
- (iv) Lime
- (v) Ferrous Metals and Non-ferrous Metals
- (vi) Steel
- (vii) Mortar and Concrete
- (viii) Building Finishing Materials
- (ix) Miscellaneous Materials

SESSION 1: STONES

1. Stones

Stone is a natural material obtained from rocks. The stones which are used for construction of various

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structures are known as building stones. There are different types of rocks and stones (Fig. 2.1) The occurrence and characteristics of these stones vary. Some often used stone forms are granite, gneiss, marble, basalt, slate, sandstone, limestone, *kankar*, laterite, quartzite, chalk, compact limestone, serpentine, etc.

Uses of stones

Stones are widely used in the form of—

1. blocks in the construction of buildings, lintels, arches, walls, columns, abutments and piers of bridges, etc.
2. stone ballast (broken stone) for railway track, road construction, preparation of cement concrete mixture for foundation in the form of coarse aggregates, flooring, artificial stones and reinforced cement concrete.

Characteristics of good building stones

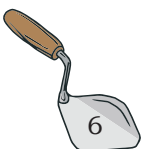
1. Appearance: good building stone would have a uniform colour, would be free from clay holes, bands or colour spots.

2. Strength: sturdy building stones should be able to withstand compression as the stones used in building construction are generally subjected to compressive strength. Compressive strength is the capacity of material or structure to resist or withstand breaking under high pressure. Generally, compressive strength of building stone varies from 60 to 200 Newton per square mm.

3. Structure: a good building stone has uniformity of texture. It should be either closed grained or crystalline and free from cavities and cracks also.

4. Hardness: the hardness of certain stones may define their durability. The coefficient of hardness should be more than 14. It should be able to resist the abrasive forces caused due to wear and friction.

5. Heaviness: the stones of heavier varieties are more compact, less porous and have greater specific gravities.



The specific gravity of good building stones ranges between 2.4 to 2.8.

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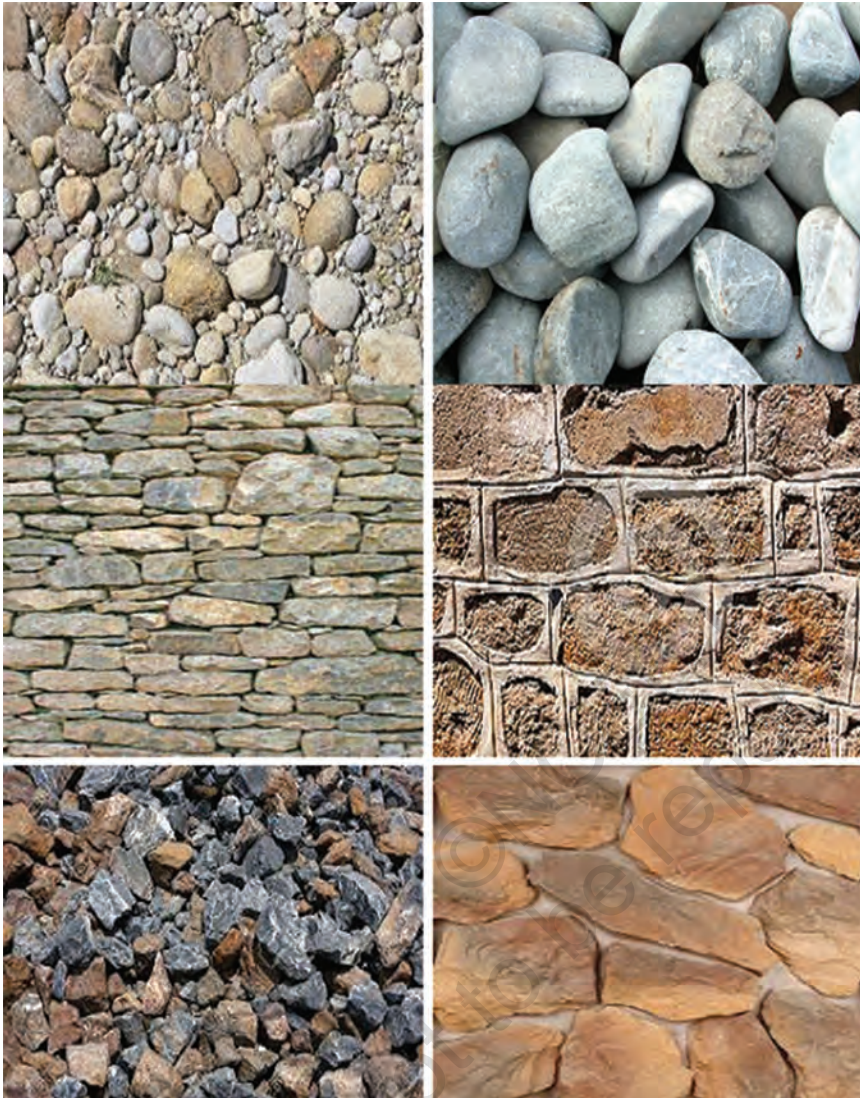


Fig.2.1: Different types of stones

6. Toughness: a stone's toughness is assessed by its ability to withstand stresses developed due to vibrations of moving loads applied over it.

7. Durability: good building stones should be able to resist various atmospheric actions, such as extreme temperatures, wind, rain, etc. The effect of atmospheric conditions on stones is known as weathering. Stones with such properties would be more useful in construction work.

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8. Seasoning: the amount of moisture contained in freshly quarried stones is known as quarry sap. This makes the stones softer and easier to work with.

9. Dressing: the art of converting a natural stone into definite shape is known as dressing. Stones should have good dressing properties, i.e. be easily workable.

10. Porosity and absorption: very porous stones are not suitable for construction works. A good building stone should not be porous and should not absorb water when immersed.

11. Resistance to fire: stones should be able to resist high temperature and should be resistance to fire.

12. Availability: the stone should be easily and economically available.

Practical Activity

Activity 1

Visit a stone market and collect samples of different types of stones used for building and identify them

Material required

Writing material and a scale

Procedure

1. Identify a construction stone selling shop.
2. Select various types of stones available in the shop.
3. Interact with your teacher and identify the different types of stones.
4. Discuss the properties of these stones.

Activity 2

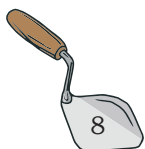
Visit a stone quarry, observe the activities there and prepare a report.

Material required

Writing material and a scale

Procedure

1. Visit a stone quarry.
2. Interact with your teacher to understand the process and activities being undertaken at the site.
3. Make a report of your observations at the site.



Check Your Progress

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A. Write short notes on

1. Use of stone in building construction
2. Characteristics of good building stones
3. Types of stone used in construction

B. Fill in the blanks

1. Stones are used in the form of _____ in the construction of buildings.
2. _____ is obtained from rock.
3. Stones are resistant to _____.
4. The effect of atmospheric conditions on stones is known as _____.
5. The specific gravity of good building stones ranges between _____.

C. Multiple choice questions

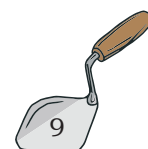
1. The art of converting a natural stone into definite shape is known as _____.
(a) dressing (b) heaviness
(c) seasoning (d) good stone.
2. Good building stones should be able to resist various atmospheric actions like _____.
(a) temperature (b) wind
(c) rain (d) All of the these
3. The specific gravity of good building stones ranges _____.
(a) between 2.4 to 2.8 (b) more than 2.8
(c) less than 2.4 (d) None of these

SESSION 2: CLAY PRODUCTS (BRICKS, TILES AND TERRACOTTA)

Clay, silt and sand are the basic ingredients of earth. These are the natural substances produced as a result of weathering or disintegration of soft rocks. Clay contains considerable amount of particles smaller than or equal to 0.002 mm size. The materials which are made from clays or their compounds are called clay products. These are widely used as building materials. Bricks, tiles and terracotta are the commonly used clay products.

Bricks

They are the blocks of tampered clay moulded into suitable shapes and sizes and are extensively used as building material. Moulded bricks are first allowed to



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dry and then burnt in kilns to make them strong, hard and durable. Generally, bricks are rectangular and length of the brick is equal to twice the width plus the thickness of mortar joint. The thickness of brick is less than or equal to the width of a brick.



Fig. 2.2: Bricks

Classification of bricks

Bricks may be broadly classified into two categories i.e., sun-dried or *kutchha* bricks and burnt bricks or *pucca* bricks. *Kutchha* bricks are made by sun drying of moulded clay mass. and *pucca* bricks are made by burning of sun-dried bricks in kilns. (Fig.2.2)

Size of bricks

As per the Bureau of Indian standards, New Delhi, the size of common clay bricks should be 19 cm × 9 cm × 9 cm. The brick size is taken as 20 cm × 10 cm × 10 cm with the mortar joint. However, if thinner bricks are required for specific purpose then they should be 19 cm × 9 cm × 4 cm without mortar thickness and 20cm × 10 cm × 5 cm with mortar joints. The minimum compressive strength of standard bricks should be 35 kg/cm².

Characteristics of good bricks

The characteristics of good bricks are that they

1. are rectangular in shape, compact in texture and uniform throughout with sharp edges.
2. are sound, hard, well-burnt and should have uniform red colour.

3. emit metallic ringing sound on striking with each other.
4. are free from holes, lumps, stones and particles of uncombined lime.
5. do not absorb more than 20 % water of their dry weight after 24 hours of immersion in normal water.
6. do not break when struck against another brick or when dropped flat from a height of about one metre on ground.
7. are hard enough and finger nails may not be able to make any impression on their surface, when scratched.

It is necessary to conduct certain field tests of bricks so that proper bricks may be selected for construction works. Some of the field tests are summarised below.

Field testing of bricks

The shape and size of the bricks should be checked. Bricks should have truly rectangular faces and their size should be exactly the same as specified by BIS. All edges of bricks should be sharp and right angled. The soundness of bricks can be estimated by striking two bricks against each other or hammering by light hammer. The bricks should emit metallic ringing sound. The soundness of the bricks can also be field tested by dropping the bricks flat on the hard ground from a height of about one metre. The bricks should not break on dropping. The hardness of bricks can be estimated by scratching on the bricks with a finger nail. If no impression of nail scratch is left on bricks then these are considered to have sufficient hardness.

Tiles

Tiles are also clay products in the form of thin slabs. They are much thinner than the bricks and manufactured from a superior quality clay. Tiles are widely used for covering roofs, floor surfaces and for making drains. (Fig. 2.3)

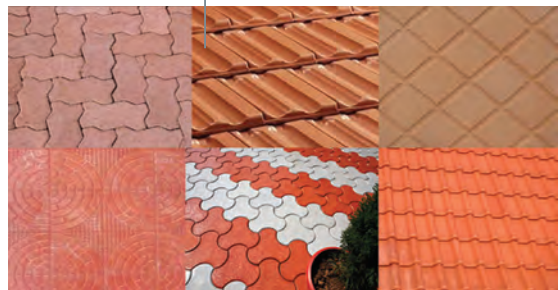


Fig.2.3: Different types of tiles

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Types of tiles

On the basis of the use, the tiles are mainly classified into three categories, viz., flooring tiles, roofing tiles, drain tiles.

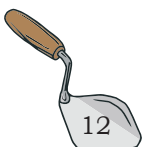
Flooring tiles

These tiles are used for covering floor surfaces of buildings. They are either made of clay or concrete. Clay flooring tiles are made of even textured superior quality clay like china clay (Kaolin). This clay has pure white colour and it is refractory. Certain amount of sand (silica) is added in clay to minimise the shrinkage. Flooring tiles are usually thicker than the roofing tiles and their thickness varies from 15mm to 30mm. Similarly, their sizes may vary from 150mm×150mm to 300mm×300 mm. The commonly used tiles have sizes 150mm×150 mm (6" × 6"), 150 mm × 75 mm (6" × 3") and 100mm×100mm (4" × 4") with 9 mm (3/8)" thickness. They may be of square, hexagonal or any other geometrical shapes. The tiles may also be coloured to achieve any desired shade. The top surface of flooring tiles is mostly glazed, whereas, the bottom surface is left unglazed to allow effective adhesion with surfaces.

General properties of flooring tiles

The flooring tiles should possess the following properties.

1. They should be of pleasant appearance.
2. They should be non-absorbent and easy to clean.
3. They should offer sufficient resistance to wear and tear, temperature and chemical action. They should be strong and durable.
4. They should be affordable, since they are used in a large quantity.
5. They should offer sufficient resistance against dampness in buildings to ensure healthy environment.



Types of flooring tiles

The flooring tiles are manufactured in different shapes, sizes and colours. Some of them are described below.

1. Sanitary tiles: are made up of dry mixture of fire clay and crushed stone. Generally, these are available in 150 mm x 150 mm size. They have glazed top surfaces and are used on floors and walls.

2. Mosaic tiles: are made up of cement concrete and their top surface is finished by using marble chips in cement mortar. Generally, they are made in 150 mm × 150 mm size. They may be prepared in beautiful colours and patterns.

3. Cement tiles: are rectangular in shape and their size is generally 150 mm × 150 mm. The top surface of these tiles is finished using pure cement. These tiles are used in chowks and verandah of low-cost houses. Precast paver blocks are commonly used nowadays for roadside sidewalls.

4. Porcelain tiles: are known as glazed tiles also. These are made of earth covered by a thorough glaze on the top surface. These are commonly used in bathrooms, water closets, kitchens, hospitals, sinks, etc.

5. Ceramic floor tiles: are made of clay, colouring and leaning agents. They are made in various shapes and sizes, such as square, rectangular, triangular and hexagonal, etc., with different colours. Ceramic tile floors are water proof, hard and resistance to wear, acid and alkalis.

6. Roofing tiles: are used to cover pitched roofs. They are manufactured in various shapes and sizes, for example, grooved, flat or ridged, etc. Clay roofing tiles are hard, durable and waterproof. and easy to maintain.

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General properties of roofing tiles

Roofing tiles should have the following properties.

1. The shape and size of roofing tiles should be such that the rainwater may be drained off from the roof.
2. These should be easily available and economical.
3. Roofing tiles should be well burnt, durable, and strong.
4. These should be non-conductor of heat.
5. These should provide decorative and pleasing appearance.

Types of roofing tiles

The roofing tiles are of different types and generally named according to their shapes and patterns. Some of the commonly used roofing tiles are described below.

1. Plain or flat tiles: are ordinary tiles having rectangular shape. Generally, they are manufactured in 250 mm × 150 mm to 280 mm × 180 mm sizes. Their thickness ranges from 10-17 mm. Plain tiles may have either continuous projection turned downwards at one end or may have two small nibs projecting downwards. These nibs help in the hanging of tiles on the glass of roof. The width and depth of nibs should not be less than 20 mm and 10 mm, respectively.



Fig.2.4: Allahabad Tiles



Fig.2.5: Mangalore Tiles

2. Allahabad tiles: consist of two sets of tiles. The lower tiles (under tile) are channel shaped flat tiles having upturned sides; whereas the upper tiles (over tiles) are semi-circular. The length of channel shaped part is kept 380 mm. The width of channel shaped tile at one end is kept 270 mm whereas, that on the other end is reduced to 230 mm. The pattern of these tiles is shown in Fig. 2.4. These tiles are fixed on ground work prepared by wooden battens on the roof slopes. Semi-circular tiles are moulded on a potter's wheel.

3. Mangalore tiles: are manufactured by moulding suitable clay under pressure. Mangalore tiles are flat pattern tiles with suitable key projections. They interlock at sides with each other and have a projecting

nib on the underside of top edge to rest against a batten. The arrangement of Mangalore tiles on a sloping roof is shown in Fig.2.5. These tiles are very strong, hard and classified in class 'A-A' and class 'A' categories. These tiles are generally available in three sizes.

4. Concrete tiles: are made using cement and aggregate (3 mm size) mixture. They are manufactured by machine moulding under pressure. The overall size of concrete tiles is 370 mm × 220 mm. These are more than 9 mm thick. These may be produced in various colours by adding desired pigments to suit the architectural requirements. They are becoming popular because of their uniform texture, high strength and good weather resistance properties.

Qualities of good tiles

Good tiles should have the following qualities.

1. They should be made of superior quality clay.
2. The shape and size should be true and regular.
3. They should be well burnt and possess uniform colour.
4. They should be free from wraps, cracks or flaws.
5. They should be hard, strong, sound and durable.

Terracotta

Terracotta is a kind of earthenware. It is generally used as substitute of stone in the ornamental parts of buildings. It is also a clay product burnt at very high temperatures. Good quality clay is required for manufacture of terracotta. Clay should have 5-8 % of iron oxide and about 1% lime. Crushed pottery, white sand and ground glass are also added in the clay to provide strength, rigidity and to check shrinkage while drying. (Fig.2.6)



Fig.2.6: Terracotta

Properties of good terracotta

1. It is a light, strong and durable material.
2. It is dense and uniform textured.
3. It is not affected by atmosphere agencies and acids.

4. It is cheaper than finely dressed stone and can be cleaned easily.
5. It can be manufactured in desired colours and patterns.
6. It is fire proof.



Fig. 2.7: Terracotta wall tiles

Uses of terracotta

Terracotta is used as a substitute of stone for all types of ornamental works. Hollow terracotta blocks are used for various ornamental works like masonry facing, cornices, arches, fire-proof casing of steel columns and beams, etc.

Practical Activity

1. Visit a market and collect the samples of different types of tiles.
2. Identify good quality clay.
3. Carry out different field tests of bricks.
4. Visit a brick or a tile manufacturing unit and prepare a report of your observations.

Check Your Progress

A. Fill in the blanks

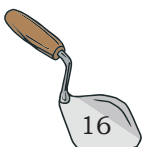
1. Brick size is generally _____ × _____ × _____.
2. Terracotta is used as _____ of stone.
3. Concrete tiles are made using _____ and aggregate mixture.
4. Mangalore tiles are flat _____ tiles with suitable key projections.
5. Roofing tiles are used to _____ pitched roofs.
6. Flooring tiles are used for _____ floor surfaces of buildings.

B. Write short notes on

1. Uses of brick
2. Mangalore tiles
3. Properties of tiles
4. Uses of tiles
5. Testing of bricks

C. Multiple choice questions

1. Good quality clay, which is required for manufacture of terracotta, should have iron oxide _____.
 (a) 5 to 8 % (b) more than 8%
 (c) less than 5 % (d) 6 to 9%



2. The minimum compressive strength of standard bricks should be _____.
(a) 32 kg/cm^2 (b) 35 kg/cm^2
(c) 37.5 kg/cm^2 (d) 36.5 kg/cm^2
3. Natural substances like clay, silt and sand are produced as result of _____ of soft rocks.
(a) destruction (b) erosion
(c) weathering (d) None of these
4. In manufacturing of flooring tiles certain amount of sand (silica) is added in clay to minimise the _____.
(a) bulk age (b) shrinkage
(c) compactness (d) conciseness
5. The soundness of the bricks can be tested by dropping the bricks flat on the hard ground from a height of _____.
(a) 1 m. (b) 1.5 to 1.8 m
(c) 0.5 m (d) more than 2 m

SESSION 3: CEMENT AND LIME

Cement

It is the basic binding material widely used in construction works. It is used for preparation of mortars and cement concrete. Cement has two forms—natural or artificial.

Natural cement

This type of cement was used in olden days before introduction of artificial cement. Nowadays, its use has become obsolete. Natural cement is achieved by burning and crushing the natural stones.

Artificial cement

It is manufactured artificially by burning mixture of argillaceous, siliceous and calcareous substances at high temperatures and then grinding the burnt mixture to fine powder. The burnt mixture of argillaceous and calcareous matter is called clinker. Little quantity of gypsum is also added in clinker before grinding to



Fig.2.8: Cement

control the rate of setting of cement. This is widely used because of the following advantages —

1. This can be manufactured in desired colours.
2. The setting rate, hardening rate and heat evolution of this cement can be regulated.
3. It can be manufactured in large quantities. There are many types of artificial cements, such as Portland cement, rapid hardening cement, quick setting cement and low heat cement, etc.



Fig.2.9: Cement with trowel

Composition of ordinary cement

Main raw materials used for manufacturing of cement are lime, silica and alumina (clay). Gypsum is also added in small proportion in order to control the setting rate of cement. Apart from these ingredients, most of the cement contain small amount of ferrous oxide, magnesium oxide, sulphur trioxide, alkalies and other materials

Properties of cement

To control the quality of cement, a standard is maintained. Important properties of cement are given below.

1. **Density:** is the ratio of mass by volume. Cement is not concrete, but can be used to make concrete by mixing it with sand, stone and water. The knowledge of the density of each of these material would allow a more accurate calculation of the proportions of a concrete mixture by volume instead of by mass. The density of cement is about 3120 kg/m^3 .
2. **Fineness:** the rate of chemical reaction largely depends upon the fineness of the cement. The finer the grading, the greater will be the rate of reaction.
3. **Consistency:** is determined by the amount of water (%) required to obtain the specified workability. The normal consistency of Portland cement is taken as 22-26%.
4. **Rate of setting:** is the phenomenon which changes a cement paste mortar to a solid but in weak stage. It is the chemical action which begins to take place when water is added to cement and results in the disappearance of the plastic nature of cement.

5. **Rate of hardening:** is the process by which weak set mortar or concrete attains strength. It indicates the growth in strength of mortar or concrete. Hardening begins at the end of initial set and proceeds rapidly during the first few days. Later it continues to increase the strength at diminishing rate indefinitely. In humid and warm surroundings cement gains strength continuously but in dry condition the hardening process stops.
6. **Waterproofing cement:** concretes prepared with this cement are more resistant to water penetration. It is used for construction of water retaining structures like tanks, reservoirs, swimming pools, dams and bridge piers, etc.

Lime

It has been considered as an important building material since ancient times. Many old forts, palaces, temples, bridges and monuments have been built using lime as cementing material. Lime is a binding material like cement. In the language of chemists, it is calcium oxide (CaO). It is still used in constructional work due to its peculiar properties.

Properties of lime

Lime is one of the basic building material used mainly as lime mortar in construction.

1. Lime provides good workability and has desired plasticity.
2. It prevents subsoil dampness due to certain level of waterproofing property.
3. Durability is high.
4. Porous texture of lime handles the moisture movement, without affecting the adjacent materials.
5. Has a higher acid resistance—due to its alkaline nature.

Uses of lime

Lime is used in various ways in the building industry.

1. It is used as a matrix for lime concrete used in building foundations and filling where early setting is not required.
2. It is used as binding material for preparation of

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- mortar for brick and stone masonry.
3. Lime is used as a cementing material in plaster for covering walls and pointing in joints.
 4. It is used for white-washing. Lime is also used to provide a base coat for distempers.
 5. Crushed limestone is used as aggregate for sand lime bricks.
 6. It is used in masonry works in the form of lime stone.
 7. It is used for water purification and sewage treatment work.

Practical Activity

1. Visit a market and collect the samples of different types of Cement and Lime.
2. Carry out the different types of field tests of cement.

Check Your Progress

A. Fill in the blanks

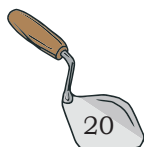
1. _____ is building material for preparation of mortar for brick and stone masonry.
2. Lime is a _____ material like cement.
3. Cement is used for _____ of mortars and cement concrete.
4. Waterproofing cement is more _____ to water penetration.
5. Crushed lime-stone is used as _____.

B. Write short notes on

1. Properties of cement
2. Use of lime
3. Properties of lime
4. Waterproof cement
5. Composition of ordinary cement

C. Multiple choice questions

1. Main raw materials used for manufacturing of cement are _____.
(a) lime (b) silica
(c) alumina (d) All of these
2. _____ is added to control the setting rate of cement
(a) Gypsum (b) Alumina
(c) Silica (d) Lime
3. The amount of water (%) required to obtain the specified workability is known as _____.
(a) durability (b) consistency
(c) fineness (d) hardened concrete



SESSION 4: FERROUS AND NON-FERROUS METALS

Metals are one of the most significant engineering materials. Various types of metals are widely used in building construction works in one form or the other, for example, as reinforcing and structural materials. These are used in doors, windows, pipes and roofing's, etc. Metals are found in nature in the compound form of oxides, carbonates, phosphates, sulphides, etc. These compounds are known as ores. All metals used for engineering purposes are grouped into two categories—ferrous and non-ferrous.

All metals wherein iron is the main ingredient are called ferrous metals viz, cast iron, wrought iron and steel. The non-ferrous metals do not contain iron as their main constituent. Aluminium, copper, zinc, lead, tin, etc., are the commonly used non-ferrous metals in building construction.

Ferrous Metals

As described above, iron is the main constituent of the ferrous metals. Iron is achieved from iron ores. The iron ores are obtained by quarrying or mining.

Types of iron

There are three general classes of iron, i.e. cast iron, wrought iron and steel. Depending upon the nature and amount of carbon content, these differ from each other. The main properties and uses of different types of iron may be described as follows.

Cast Iron

It is obtained by re-melting and refining the pig iron in a special furnace called cupola furnace. The molten product is poured into moulds of required shapes and sizes to get cast iron. It is an alloy of carbon and iron with or without other elements.

Uses of cast iron

Cast iron is used for making pipes, manhole covers, struts in trusses, castings, rainwater pipes, gutters,



Fig.2.10: Ferrous and Non-ferrous Metals

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gratings, railings, cisterns, etc. Due to its high compressive strength, it is used for making columns, supports for heavy machinery, carriage wheels, bed plates, agricultural implements, etc.

Wrought iron

Wrought iron is the purest form of iron with low carbon content. It is made from white pig iron by re-melting and removing most of the carbon, manganese, silicone, phosphorus and sulphur in the puddling furnace.

Properties of wrought iron

1. Wrought iron is the purest form of iron and it is tough, ductile and malleable.
2. It has a fibrous structure and silky lustre.
3. It can be bent and twisted in either hot or cold stage.
4. It can be easily forged and welded.
5. It becomes so soft at 900°C temperature that its two pieces can be joined by hammering.
6. It rusts easily as compared to cast iron but it is not affected by saline water.
7. Wrought iron cannot be hardened and tempered but can be case hardened.
8. Its melting temperature is 1535°C.

Uses of wrought iron

Wrought iron is used for making roofing sheets, corrugated sheets, water and gas pipes, bolts and nuts, grills, gates, window guards, rods, boiler tubes, hand rails, railway couplings, fish plates, armature and electromagnets, etc.

Steel

Steel is an intermediate form between cast iron and wrought iron. It is an alloy of carbon and iron in specified proportion. The maximum carbon content in steel is limited to 2.1% of its weight.

Nowadays, steel is being commonly used in almost all fields of engineering. In the building construction works, steels are used as basic structural material in various forms.



Types of steel

Steel containing iron and carbon only, is called carbon steel or plain carbon steel, which is ordinary steel. Carbon steel is roughly divided into two categories, viz., soft steel, which contains less than 0.45% carbon and hard steel, which contains more than 0.5% carbon.

Mild Steel

It is a soft carbon steel and may contain 0.15 to 0.50% carbon. If the carbon content is less, than 0.15% then the steel is known as dead mild steel.

Uses of mild steel

Mild steel is used for all kinds of structural steel works. In construction work, it is mainly used in the form of rolled structural sections, such as IT and channel sections, angles plates, round and square bars 1 bolts, rivets and sheets, etc. MS round bars are extensively used as reinforcing material for reinforced cement concrete. Plain and corrugated mild steel sheets are used as roofing materials.

High Carbon Steel

Any steel with a carbon content of 0.55% or higher is known as high-carbon steel. High carbon steel has high tensile strength, is hard, wear-resistant and is moderately ductile. It is used to make cutting tools, because of its ability to keep a very sharp edge under duress. It is also used for making masonry nails, which can be pounded readily into rock.

Uses of high carbon steel

High carbon steel is used for manufacture of various workshop tools, such as drills, files and chisels, etc. It is also used to manufacture those various components of machines which are expected to expose to shocks and vibrations and need a hard, durable and tough material.

Cast steel is a high carbon steel which is formed by casting. It is the strongest and most uniform steel. It can neither be welded nor forged. Cast steel is less ductile and tougher as compared to ordinary steel. It is used for making high-grade surgical instruments.

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Steel Alloys

The generally used steel alloys in construction are given below.

Stainless steel

Stainless steel is corrosion resistant and has chromium, nickel, carbon and other elements in varying proportions in its composition. Chromium is the most effective ingredient to make steel corrosion-resistant. Stainless steel usually contains 18–20% chromium and 8–12% nickel. Steel containing above 16% chromium is called stainless steel. Stainless steel of various brands are available in the market.

Uses of steel

Generally, steels are used for the following purposes.

1. As basic reinforcing material in construction works.
2. As structural material in trusses, beams, stanchions and light frames in the form of various sections.
3. As components for doors, windows and grills, etc.
4. For manufacture of pipes, tubes, tanks and ducts etc.
5. For sanitary and sewer fittings.
6. Form expanded metal and metal lath.

Advantages of steel as reinforcing material

Steel is commonly used as reinforcing material due to its following qualities.

1. Steel possesses high tensile strength and elasticity.
2. It develops good bond with concrete.
3. It is cheaply and easily available in bulk.
4. Its thermal coefficient is nearly equal to the thermal coefficient of concrete.
5. Its use is economical.

Non-ferrous Metals

Metals, which do not contain iron as their main constituent, are called non-ferrous metals.

Aluminium

It is extracted from bauxite ore by various processes. It is a bluish silvery white lustrous metal. Pure aluminium



is soft, highly ductile and malleable, hence it is alloyed (mixed) with some other metals for improvement of its qualities. It is a light, durable and easily workable metal. Aluminium is a good conductor of heat and electricity and highly resistant to corrosion. It can be welded and riveted.

However, its soldering is not possible. Sheets, plates, foils, bars, rods, wires, casted, forged or rolled structural parts and cooking utensils are the commercial forms of aluminium. Aluminium is used for making frames of doors and windows, corrugated sheets for roofing, piping, railings, posts, and panels in building construction. It is used in powdered form in paints.

Being a tough and light metal, it is very commonly used in automobile, wireless and airplane industries. It is used for making electric wires and cables, etc. Due to its good conductivity.

Practical Activity

1. Visit a market and collect the samples of different types of ferrous and non-ferrous metals.

Check Your Progress

A. Fill in the blanks

1. Iron is achieved from iron _____. The iron ores are _____ by quarrying or mining.
2. Wrought iron is the _____ form of iron with low carbon content.
3. The non-ferrous metals do not _____ iron as their main constituent.
4. Three general classes of iron are cast iron, _____ and steel.
5. High carbon steel contains 0.70 to _____ % carbon.

B. Write short notes on

1. Ferrous material
2. Non-ferrous material
3. Uses of steel
4. Wrought iron

C. Multiple choice questions

1. Which is the purest form of iron?

(a) Wrought iron	(b) Cast iron
(c) Steel	(d) None of these

2. Which among the following does not belong to the nature of pure aluminium?

(a) Soft	(b) Highly ductile
(c) Malleable	(d) Brittle
3. Stainless steel usually contains _____ chromium and _____ nickel.

(a) 18–20% and 8–12%	(b) 15–18% and 8.5–11.5%
(c) 18.5–20.5% and 7–12%	(d) 18–20% and 9–12%
4. Melting temperature of wrought iron is _____.

(a) 1535°C	(b) 1538°C
(c) 1537°C	(d) 1532°C

SESSION 5: MORTAR AND CONCRETE

Mortar and Concrete

Mortars and concretes are the mixtures of binding material, aggregate and water. These are extensively used in construction industry. Mortars and concretes shall be discussed separately in this chapter.

Mortar



Fig.2.11:Mortar

Mortar is a workable paste used to bind building block, such as stones, bricks, and concrete masonry units together, fill and seal the irregular gaps between them, and sometimes add decorative colours or patterns in masonry walls. Mortar may be defined as a plastic mixture (paste like substance) of a binding material, fine aggregate and water in appropriate proportions. Generally, cement, lime or soil, (clay) is used as binding material and sand or *surkhi* as fine aggregate for preparation of mortars.

Functions of mortars

Mortars are used for

1. uniting bricks or stones in masonry works. Concrete blocks are also bound together using mortars.
2. providing an even bed between different layers of masonry, this results the even distribution of load on the lower layers.
3. forming matrix to hold the pieces of aggregates together. This leads to formation of solid mass of concrete.

4. These are used as covering materials to wall surfaces and joints in the form of plaster or pointing. These coverings protect the masonry surfaces from weather and provide hard, durable and decorative surfaces.

Ingredients of mortars

The main ingredients of mortars include binding material, fine aggregates and water.

Binding material

Cement, lime and clay are commonly used as binding material in preparation of mortars. The soil for making mud mortar should have suitable plasticity. It should be free from vegetative roots, stones and gravels (particles size greater than 2 mm), *kankar*, coarse sand and harmful efflorescent salts.

Cement and lime are the best binding material used in the preparation of mortar.

Fine aggregates

Sand and *surkhi* are commonly used as the fine aggregate for preparation of mortars. Important qualities of commonly used fine aggregates are summarised here.

1. Sand: is the most commonly used fine aggregate for mortar preparation. Clean, coarse, hard and durable, sand should be used for mortar preparation.

Functions of sand in mortar

Sand, used in mortar preparation performs the following functions —

- a) an adulterant to increase the volume of mortar to make it economical.
- b) prevents excessive shrinkage of mortar and consequently cracking of mortar on setting is avoided.
- c) helps in setting of pure lime mortar by allowing the penetration of air, containing carbon-dioxide through voids, needed for setting of lime.
- d) helps in improving the strength of mortar or concrete.

NOTES

e) it, being an inert material, makes the structure more resistant against atmospheric agencies.

2. Surkhi: is used as a substitute of sand and obtained by grinding well burnt (but not over or under burnt broken bricks). It should not contain any harmful impurities, such as salts, iron pyrites, coal, shale and other deleterious materials. The maximum quantities of clay, silt, dust and organic impurities in surkhi should not exceed 5% by weight.

3. Cinder: is used as fine aggregate for mortar preparation. Cinder obtained from the furnace of steam boilers should only be used.

4. Fly ash: is obtained from the combustion of pulverised coal in boilers. It is used for partial replacement of cement in mortar or concrete. Nowadays 10-20% fly ash is added as replacement of cement in cement bags. This helps in environmental preservation as well as cost reduction.

5. Water: to be used for mortar preparation should be clean and reasonably free from injurious quantities of deleterious materials, such as oils, acids, alkalis, salts and vegetative growth. Generally, drinking water should be used for mortar preparation.

Proportioning of mortars ingredients

The strength and durability of masonry considerably depends on the mortar used.

The composition of mortars is designated by two or three numbers, for example, the composition of ordinary Portland cement mortar is designated as 1:4. This means that in a given mortar, four unit volume of sand are mixed with one unit volume of cement. The composition of compound mortar is designated by three numbers; a cement lime mortar of 1:0.5:5 composition contains one part of cement, 0.5 part of lime and five parts of fine aggregate (sand) on volume basis. These compositions are prepared on the basis of laboratory tests conducted for various proportions of mortars.



Classification of mortars as per use

NOTES

Mortars may be classified as per use in the following ways:

Mud mortar

This is also called Gara and is the cheapest mortar. It is prepared from a mixture of soil (clay) and water in appropriate proportions. The mixture is mixed under feet to get required consistency. Spade is used for turning and mixing of mortar. It is mostly used in villages in *kutchha* and *pucca* masonry works. However, plastering or pointing of masonry is necessary to maintain durability and to avoid erosion due to rains. It can also be used for plastering of *kutchha* huts and for erection of mud walls. Straw should be mixed at a rate of 1–18 kg of dry soil while using it for erection of mud walls.

Cement mortar

This is a stronger mortar and preferred for construction of structures subjected to heavier loads, for example load bearing walls, pillars and columns, etc. It consists of the mixture of cement, sand and water in appropriate proportions. Generally, the proportion of cement to sand varies from 1:2 to 1:6 or more. It provides impervious surfaces and advantageously used for external walls, exposed situations and underground structures.

For preparation of mortar, cement is measured in bags. Each bag contains 50 kg cement having 32 litre volume. Sand is also mixed on the basis of dry volume but appropriate allowances should be provided considering bulk age of sand.

A box of 25×35×40cm size may be prepared and conveniently used for measurement of sand. Cement and sand is mixed in required proportions in dry state on an impervious plate form. Some of the commonly used proportions of cement and sand mortar for specific purposes are presented in table.

Table 2.1: Commonly used proportions of cement-sand mortar

S.no.	Work	Ratio
1.	Masonry work	1:6 to 1:8
2.	Foundation concrete	1:3 to 1:4
3.	R.C.C. works	1:3
4.	Arch works	1:3

S.no.	Work	Ratio
5.	Plastering work	1:3 to 1:6
6.	Pointing work	1:1 to 1:3
7.	Damp-proof course	1:2
8.	Partition walls	1:3
9.	Lintels, pillars, slabs and stairs, etc.	1:2

Lime mortar



Fig.2.12: Lime Mortar

It consists of mixture of lime, sand and water in suitable proportions. Sand is added to control shrinkage. Slaked fat lime is used in mortar to be used in plastering and hydraulic lime is used for preparation of mortar to be used in masonry construction works. Lime mortar may be composed of lime-sand, or lime-surkhi, or lime-sand-surkhi or lime-cinder (black mortar).

Properties of good mortar

Effective mortars should have —

1. smooth mobility (mobility of mortar is its ability to spread easily over the surface in the form of thin layer and fill all irregularities).
2. water holding capacity and should not bleed (water holding capacity is the property of mix to hold water when placed on a surface). In case of bleeding, water flows away and fine aggregate (sand) is separated.
3. enough strength and good adhesion to hold bricks and stones, etc.
4. the ability to set and harden quickly and should provide durable surfaces.



Fig.2.13: Concrete

Concrete

Concrete is a mixture of a cementing material, fine aggregate, coarse aggregate and water along with or without a suitable admixture.

Generally, sand is used as a fine aggregate and crushed stone or crushed boulders or

gravels are used as coarse aggregates. Admixtures are the ingredients or the substances which are added in concrete to improve its various properties, such as workability, setting time, etc. Commonly used admixtures include alum, common salt, lime, aluminium sulphate, bitumen and calcium chloride, etc.

When cement is used as cementing material in concrete mix then it is known as plain cement concrete. If steel is used to provide reinforcement in cement concrete, it is called Reinforced Cement Concrete (RCC).

If lime is used as cementing material then it is called lime concrete. Reinforcement cannot be provided in lime concrete because it eats away steel in due course of time. Sometimes, part of sand is replaced by *surkhi* and thus achieved concrete is called surkhi concrete. Freshly prepared concrete (that has not yet set) is called wet or green concrete. After thorough setting and hardening of concrete, it is called set concrete or hardened concrete.

Nowadays, concrete is extensively being used for all types of construction works in various forms, for example, plain or reinforced or precast concrete, etc. Concrete is mainly used in foundations, columns, beams, slabs, stair cases, lintels, door and window frames and storage tanks, etc., in building construction works.

Ingredients of concrete

Cement

This ingredient binds the aggregates together and provides strength, durability and water tightness to concrete. It is an active constituent of concrete.

Aggregates

The aggregates act as fillers in concrete. These are used in concrete to provide economy in the cost of concrete as well strength. Aggregates occupy about 80 to 85% of concrete volume and form its rigid skeleton, which prevents shrinkage and contraction.

Sand is used as a fine aggregate in preparation of concrete. Stone, gravel and brick ballasts are commonly used as coarse aggregate for preparation of concrete.

NOTES

Aggregates should be staked separately according to their nominal sizes.

Advantages of concrete

1. The ingredients of concrete are easily available for concrete preparation.
2. Handling of concrete is easier and it can be moulded in any desired shape.
3. Concrete can easily be transported from the place of mixing to the place of casting.
4. When concrete is reinforced then all types of structures are made possible, for example, from ordinary lintel to massive flyover.

Disadvantages of concrete

1. It has low tensile strength and requires reinforcement to avoid cracks.
2. Soluble salts in concrete cause efflorescence after reacting with moisture.
3. Sustained loadings develop creep in concrete structures.
4. Construction joints are provided to avoid cracks because of drying shrinkage and moisture expansion.

Types of concretes

Cement concrete

It is mixture of cement, sand, gravel or pebbles and water in appropriate proportions. Some materials like alum, common salt or calcium chloride, etc., may also be added in cement concretes to improve its properties.

Cement concrete is an important structural material and extensively used in variety of construction. It is strong in compression and weak in tension. Generally, coarse aggregates having upto 63 mm diameter are used for mass concrete; whereas aggregates having upto 25mm diameter are used for preparation of concrete for slab, beam and columns, etc. The concrete mixes having 1:2:4, 1:3:6 and 1:4:8 proportions are generally used and known as strong, medium and lean mix, respectively.

Lime concrete

It is the mixture of slaked lime, fine aggregate, coarse aggregate and water in suitable proportions. Hydraulic lime is always used in preparation of this concrete.

Lime concrete is extensively used as levelling coarse for foundations of the buildings and as base concrete under floors. It is also used to provide roof finishes and used for filling of haunches over masonry arch work. Lime concrete is cheaper than cement concrete.

Surkhi concrete

This is prepared by mixing slaked lime, sand, *surkhi*, coarse aggregate and water in appropriate proportions. Surkhi concrete having 1:1:5:0.5: 4 (lime, sand, *surkhi* and coarse aggregate) proportion is commonly used in various construction works.

Composite mortar concrete

This is a mixture of cement, non-hydraulic lime, sand, coarse aggregate and water in appropriate proportions. Different proportions of composite mortar concrete are used for different types of works like basement concrete floor, etc.

Reinforced Cement Concrete (RCC)

We know that plain cement concrete is strong in compression but weak in tension and shear. The cement concrete can be made stronger in tension also by embedding steel bars in it.

The concrete, in which reinforcing metals have been embedded to enable it to take up tension safely, is called reinforced cement concrete. Generally, steel is used as reinforcing material because it possesses high tensile strength and elasticity. Steel develops good bond with concrete and it is cheaply and easily available in bulk. Its thermal coefficient of expansion is also nearly equal to that of concrete.



Fig.2.14: Reinforced Cement Concrete

Advantages of R.C.C.

The R.C.C. has following advantages over plain concrete.

1. R.C.C. structures are strong enough. The combination of concrete and steel provides much rigidity to structures.

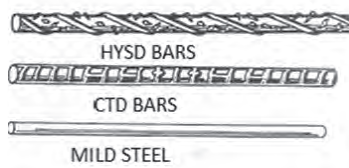


Fig.2.15 Types of Reinforcement

2. The maintenance cost of R.C.C. structures is less because these are not affected by termites, etc.
3. The combination of concrete and steel is economical because compressive forces are borne by concrete and tensile forces by steel.
4. R.C.C. structure are almost impervious.
5. R.C.C structure are durable and can with stand fire.
6. R.C.C. structures can be constructed of any desired shape.

Uses of R.C.C.

Reinforced cement concrete is extensively used in all sorts of construction works of buildings, bridges, arches, tanks and massive dams, etc.

Practical Activity

1. Carry out the volumetric measurement of sand and coarse aggregates.
2. Prepare cement mortar by hand mixing
3. Prepare cement concrete by hand mixing
4. Visit a construction site and observe the method of mixing of cement concrete by machine mixing.

Check Your Progress

A. Fill in the blanks

1. Mortar is the basic _____ used in stone and brick masonry and in other structural units.
2. Cement, lime and clay are commonly used _____ materials in preparation of mortars.
3. Sand and *surkhi* are commonly used as the _____ aggregate for preparation of mortars.
4. *Surkhi* is used as substitute of _____ and obtained by grinding well burnt broken bricks.
5. Mud mortar is also called _____ and is cheapest mortar.
6. Cement concrete is _____ of cement, sand, gravel or pebbles and water in appropriate proportions.
7. Reinforced cement concrete is extensively _____ in all sorts of _____ works of buildings, bridges, arches, tanks, massive dams, etc.



B. Write short notes on

1. Concrete
2. Mortar
3. Reinforced Cement Concrete(RCC)
4. Lime Concrete
5. Aggregates

C. Multiple choice questions

1. Aggregates occupy about _____ of concrete volume.
 (a) 80 to 85 % (b) 80 to 90 %
 (c) 70 to 85 % (d) 82 to 85 %
2. Concrete Ratio 1: 2: 4 is designated as _____.
 (a) M-10 (b) M-20
 (c) M-15 (d) M-7.5
3. Cementious material produced in thermal power plant which also a waste is known as _____.
 (a) cinder (b) *surkhi*
 (c) cement (d) fly ash
4. Which of the following is the best binding material?
 (a) Cement (b) Fly ash
 (c) Lime (d) *Surkhi*

SESSION 6: BUILDING FINISHING MATERIAL

Building Finishing Material

The material which are used to provide the building finishes or the final look are called building finishing materials. Common building finishes include plastering, pointing, white-washing, colour washing, wall papering, painting, varnishing, polishing, etc. Building finishes are done with the following objectives.

1. To provide decorative appearance on material surfaces and building as a whole.
2. To provide a protective coating to surfaces against various weathering effects, such as rust and heat, etc. The materials used in building construction are protected and preserved by this coating.
3. To maintain hygienic conditions in the buildings.

NOTES

Various types of building finishes and materials required are given here.

Plastering

A plaster is a thin coat of mortar of different composition, which covers the face and hides the joints of walls and ceilings of buildings. The process of covering various surfaces of structures with a plastic material, such as cement mortar, lime mortar, composite mortar or mud mortar is called plastering. It provides an even, smooth, regular, clean and durable surface. Plastering conceals the slight flaws of workmanship also. It further provides a protective coating against atmospheric effects and base for receiving other decorative finishes; for example, white washing, colour washing, painting, etc. When plaster is applied on the external exposed surfaces of walls, then it is called *rendering*.

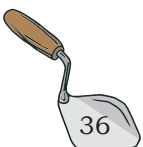
Pointing

The art of finishing the mortar joints in the exposed brick or stone masonry using suitable mortar is called pointing. It protects the joints from weather effects and improves the appearance of the buildings. In plastering, whole surface is covered with mortar, whereas, in pointing, only joints are filled with mortar.

Pointing is usually carried out using cement or lime mortar but sometimes composite mortars are also used. The cement mortar for pointing is prepared by mixing cement and sand in ratio of 1:2 or 1:3. Similarly, lime mortar is prepared by mixing equal parts of fat lime and fine sand and grinding the resultant mixture thoroughly. Composite mortars having cement:lime: sand proportion in 1:3:10 or 1:4:16 are successfully used for pointing work. The mortars must be well pressed into joints at the time of pointing.

White washing

It is the process of application of wash covering to the plastered surfaces. The white wash is prepared using pure fat lime or shell lime. Since shell lime is whiter, slakes more perfectly and makes smoother paste as compared to lime stone, so it is preferred for preparation



of white wash. Lime is brought to site in unslaked condition and it is slaked in a tub with sufficient quantity of water. It is allowed to remain in the tub for 24 hours and then stirred to attain the consistency of thin cream. Approximately 5 litre water should be added into 1kg of lime for making cream. Before application of white wash, the surface should be cleaned properly. White wash may be applied using *moonj* brush. A vertical stroke followed by a horizontal stroke constitutes one coat of white wash.

Colour washing

Colour washing is similar to white washing. Colour wash is prepared by adding appropriate quantities of necessary colouring pigments into the strained white wash. This preparation is mixed well. Mineral colours, which do not get affected by lime should be added with white wash.

While preparing the colour wash, it should be kept in mind that the prepared quantity of colour wash should be used in the same day that it is prepared. For new surfaces priming coat of white wash should be provided followed by one or two coats of colour wash as per the need. Also, for replacing one colour with another, a coat of white wash should be applied followed by the desired colour wash. The method of application of colour wash is same as of white wash.

Distempers

The process of application of distempers on the various surfaces is called distempers. Distempers form a cheap, durable and easily applied decoration for internal use on plastered surface, cement concrete and various wall board surfaces. Distempers are known as water paints also.

Wall papering

The process of pasting of papers on the walls and ceilings inside the rooms is called wall papering. It is performed to provide beautiful appearance inside the rooms and buildings as whole. The wall papers are made exclusively from papers or combined with other materials. Usually, wall papers are available in different colours.

Method of Wall Papering

The surfaces, to which wall papers are to be pasted, are dried, levelled and freed from dirt, white or colour wash or any other solution. All the cracks, slits and pits are filled with lime gypsum putty solution. This is followed by pasting of wrapping paper or newspaper on the prepared surfaces. Then, wallpapers are pasted on it. Pastes prepared from wheat flour, starch, joiner's glue, synthetic resins or gluing mastics are used to paste papers on the walls. The wallpapers are available in rolls or sheets in the market. Papering is not suitable in damp climate and places infested with white ants.

Paints



Fig.2.16: Paint boxes

Paints are the ready mixture of material which are applied, in the liquid state, to all surfaces as a final finish. Generally, these are applied on walls, ceilings, wood and metal works. The process of application of paint in the form of coating is called painting. The purpose of painting is to prevent corrosion of metals and to protect wood from decaying, protect various surfaces from weathering effects (heat, moisture and gases) of atmosphere and to provide decorative finish and attractive appearance to all the surfaces.

Paints are classified as oil paints, water paints, cement paints and bituminous paints. There are, some special purpose paints also, which are used for painting, such as, heat resistant paints, water proofing paints, chlorinated rubber paints for protection against acid fumes and luminous paints for visibility of painted surface in dark, etc.

Types of paints and their uses

Aluminium paints

These paints consist of aluminium powder suspended in spirit or oil varnish. After evaporation of suspension liquid, i.e., spirit or oil, a thin metallic coating of Aluminium particles are formed on the painted surface. It is visible in darkness due to its silvery shining texture.

It has very good covering capacity and provides nice protection to iron and steel against corrosion. It is heat, electric and weather resistant. It is commonly used for painting hot water pipes, oil storage tanks, gas tanks, metal roofs, silos, electric and telegraph poles, marine piers, radiators and other machineries. It is used for painting wood work also.

Anticorrosive paints

As the name indicates, these paints are anticorrosive in nature. These paints consist of oil, a strong drier and a colouring pigment mixed with fine sand. These are durable and provide black appearance to painted surface.

Asbestos paint

The fibrous asbestos is the main ingredient of this paint. This paint has fire retarding quality. It can also withstand the effects of water, steam and acidic gases. It is commonly used for painting of public buildings. It is also used to check the leakages from metal roofs. This paint is also used for gutters, spouts and flashings, etc. to protect them from rusting.

Bituminous and tar paints

These paints are prepared by dissolving bitumen or tar in naphtha or petroleum or white spirit. Generally, these paints are black in colour but their colour may be modified by addition of colouring pigments, like, red oxide, etc. These paints have high covering capacity.

Bituminous paints are especially used for painting of iron and steel structures under water. These paints are also used for painting of plastered surfaces and exterior brickworks.

Oil paints

These paints are cheap, durable, weather resistant and present good appearance. These paints are generally used for all type of surfaces, for example, wood work, walls, ceilings and metal works. These are applied in three different coats, i.e. priming coat, under-coat and finishing coats, etc.

NOTES

Cement paint

It is prepared by mixing cement (65–75%) Portland, white or coloured cement) into boiled Linseed oil. Cement paint has good strength, hardness, density, durability and possesses better waterproofing quality. It provides nice decorative appearance. Cement paint is used for painting of stone masonry, plastered brick masonry and corrugated iron sheets.

Emulsion paints

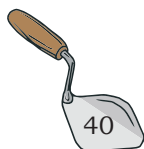
These paints are durable, alkali resistant, easily workable and have quick drying quality. Emulsion paint has enough toughness and retains its colour for long time. These are used for painting of surfaces containing free alkali like stucco and brick masonry.

Enamel paints

The main constituents of enamel paints are metallic oxide (zinc oxide or lead oxide), oil, petroleum spirit and resinous matter. These paints dry slowly and leave a hard, tough, smooth and durable film on the painted surface. Enamel painted surfaces are washable and resistant to acids, alkalies, gases and steam. These paints have flow properties and leave no brush mark on the painted surface. These paints are equally good for painting of external and internal works and has glossy appearance. Enamel made from synthetic resins are known as synthetic enamels. These dry quickly and are more durable.

Plastic paint

Various types of plastics are used as base of these paints. These paints are available in market in different shades and trade names. When water is used as thinner then, these are called as plastic emulsion paints. Plastic paints dry quickly and provide decorative appearance. These have good adhesion and high covering capacity. Plastic paints are used at the places where attractive appearance is desired, for example, cinema halls, offices, auditoriums, showrooms, etc.



Fire-proof paint

Coatings of sodium tungstate and asbestos paints are used to retard the fire action. These are known as fireproof paints. Either of these solutions is used to provide fire resistant quality to timber works.

Colour scheme for walls

Red, yellow and blue are the three primary colours and all other colours are mixtures of these three. Red, orange and yellow are called warm colours; whereas, violet, blue and green are called cool colours. White, pure greys and black are called neutral colours. Excess of red or orange is upsetting, most uncomfortable to live with in hot climate.

The selection of right colour is very important before its application. The right colour can make a room look bigger. White colour is popular in contemporary homes. It gives a crisp finish to a scheme and looks light and fresh. Blue is usually a difficult colour. In a blue room, wall reflects strongly upon each other. Pink becomes paler with time. Grey is essentially a cool and excellent background colour.

Varnish

Varnish is a solution of resinous substances in either oils, turpentine or alcohols. Resinous substances, such as, amber, copal and shellac are used in preparation of varnishes. After drying, varnish leaves a hard, transparent and a glossy film of resins on the varnished surfaces. The process of application of varnish on various surfaces is known as varnishing.

Varnish is applied to the painted surface to increase its brilliance and to protect it from the atmospheric actions. Thus, it increases the durability of the paint film. Varnish is also applied on the unpainted wooden surfaces to brighten the ornamental appearance of the grains of wooden surfaces, such as doors, windows, floors, roof trusses, etc.

Ingredients of varnish

Resins, solvents and driers are the main ingredients of the varnishes.



Fig.2.17: Varnish

NOTES

Types of varnish

Oil varnish

These varnishes are prepared by dissolving hard resins such as amber and copal, etc., in linseed oil. Small quantity of turpentine is also added to achieve its proper workability. These varnishes are most durable and hardest as compared to all other varnishes. These provide higher gloss and smoother finish to the varnished surface. Oil varnishes are used for varnishing of interior and exposed surfaces which require polishing and frequent cleaning. Flat varnish is also an oil varnish having high proportion of resins.

Turpentine varnish

Turpentine is used as solvent in preparation of these varnishes. Various soft resins, such as mastic, gum *dammar* and common resins, etc., are dissolved in turpentine oil. These varnishes are cheaper, lighter in colour, more flexible and dry quickly than the oil varnishes.

Polish

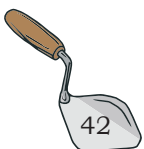
Polishes are thin varnishes, which are lightly rubbed on the surfaces just like the brush polish.

Furniture polish

As the name indicates, it is generally used for polishing furniture. It can be prepared at the domestic level by mixing following ingredients in the suggested proportions.

Wax polish

Wax polish is prepared by mixing two parts of beeswax with two parts of boiled linseed oil over the slow fire. After some time the wax gets dissolved in the oil. Now one part of turpentine is added in this slightly warm mixture. Thus prepared, the polish is ready for use. It is rubbed into the pores of wood with cotton pad. For a good finish, normally three applications are required. Wax polish is mostly used for polishing cement concrete floors.



Lacquer

Lacquer is like a very thin varnish. It consists of shellac, methylated spirit and colouring pigments. Depending upon the desired use, these may be mixed in different proportions. On drying, these provide a tough and durable finish. Lacquers are used for furnitures, brass surfaces, floor and linoleum, etc.

Stains

Stains are liquid preparations. Aniline is mostly used as base and water, oil and alcohol, etc., as vehicle in preparation of stains. These are named after the vehicle used in their preparation. Water stains are cheapest but provide rough coating on the wooden surface. Spirit stains dry very quickly hence require an expert painter for their application. Oil stains are most suitable for their use on hard wood works.

Wall tiling

The process of lining or finishing the walls with special tiles (either for height varying from 60–120 cm above the floor level or up to the ceiling) is known as wall tiling. Generally, wall tiling is used in passages, kitchens, bathrooms, fire places, staircase walls and boiler rooms, etc. Wall tiling is provided to give decorative effect over the surfaces. The wall tiles are either of terracotta, faience, China clay or marble. They are available in variety of colours, sizes and thicknesses.

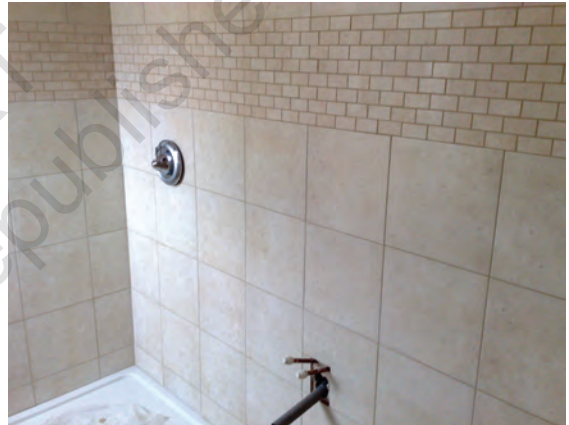


Fig.2.18: Wall Tiling

Whitening

It is the process of whitening the walls and ceilings by a mixture of ground chalk, glue and water.

Coal tarring

The process of application of coatings of coal tar to wood work or iron work is called coal tarring. It is done to preserve the surfaces. The tarred surfaces can further be treated by varnishing or painting.

NOTES

Wood oiling

It is used as a substitute for painting on woodwork. It is done to increase the durability and to improve the appearance of surfaces. Generally, linseed oil, turpentine or sweet oil is used for oiling.

Practical Activity

1. Visit a market and look for building finishing materials.
2. Prepare the following paints:
(i) White washing, (ii) Colour washing, (iii) Distemper, (iv) Oil Paint, (v) Furniture polish

Check Your Progress

A. Fill in the blanks

1. A plaster is a thin coat of _____ of different composition.
2. Process of pasting of papers on the walls and ceilings inside the rooms is called _____.
3. The art of finishing the _____ joints in exposed brick or stone masonry using suitable mortar is called pointing.
4. The process of lining or finishing the _____ with special tiles is known as wall tiling.
5. The process of application of coatings of coal tar to wood work or iron work is called _____.

B. Write short notes on

1. Building finishing materials
2. Plastering
3. Pointing
4. Wall tiling
5. Polishing
6. Plastic paint
7. Oil paints

C. Multiple choice questions

1. Lacquers is used for _____.
(a) furnitures (b) wall painting
(c) ceiling painting (d) None of these
2. The art of finishing the mortar joints in exposed brick or stone masonry using suitable mortar is called _____.
(a) plastering (b) white washing
(c) colour washing (d) pointing



3. Coatings of _____ and asbestos paints are used to retard the fire action.

(a) Sodium carbonate	(b) Sodium hexane
(c) Sodium tungstate	(d) Titanium oxide
4. Resinous substances used in preparation of varnishes are _____.

(a) amber	(b) copal
(c) shellac	(d) All of these

SESSION 7: MISCELLANEOUS MATERIALS

Many miscellaneous materials are designed and developed as per requirement. Some such materials popularly used are described here.

Plastics

Nowadays, plastic is being used widely in the construction industry due to its several advantages over conventional construction materials. Plastic products are light weight and provide sufficient strength and corrosion resistant property. Plastics provide better hygiene and exhibit pleasing look. Plastic is a synthetic material made from polyethylene, nylon, polyvinyl chloride, etc.

Uses of plastics

In the building industry, plastics are used for different purposes such as wall tiling, roofing, heat insulation, wall panels, doors, etc. These are used as floor coverings in domestic, administrative and industrial buildings. Different types of plastics are used in plumbing and air conditioning units in various forms, for example, pipes, couplings, elbows, union tees, shower stalls and tubes and parts and joints of sewer system and taps.

Types of plastics

PVC (Polyvinyl chloride)

It is a kind of thermoplastic achieved from vinyl chloride and acetates. It is light weight and can be easily cut. PVC can withstand wear and tear, acids and alkalies. It is not affected by moisture. PVC is used for manufacture of drainage pipes, electric wire insulation, flooring

finishes and emulsion paints, etc. PVC linoleums are used for covering floors in domestic, civil and industrial buildings. One ply linoleum is usually 1.5-2.5 mm thick; whereas felt or porous base linoleums have 4-6 mm thickness.

Polyethylene

Alkathene and Polythene are the trade names of this transparent thermoplastic. Polyethylene is used for making pipes, for cold water services, cistern ball floats water proofing material, for terraced roofs, reservoirs and canals, etc.

Perspex

It is a proprietary thermoplastic resin which provides light and tough sheets. These sheets do not break easily. Perspex sheets are exceptionally transparent and can be cut, drilled, sawn and planed easily. These are available in attractive colours.



Fig. 2.19: Decorative veneer plastic used on kitchen cabinets

Wood laminated plastics

Wood laminated plastics are used as finishing material for walls, partitions and ceiling boards in public buildings.

Decorative laminated plastic veneer

These versatile sheets are marketed under trade names of Formica, Sunmica, Sunglass and Decolum, etc. These are used where elegance, durability and hygiene are the main considerations. Table tops, wall panels, kitchen and bathroom counters, interior bodies of trains, bushes, aircrafts and ships are made from these plastics.



Fig.2.20: Glass

Glass

Glass is extensively used in building construction for various purposes, for example, for glazing doors and windows, insulation and for decoration, etc.

Properties of glass

Glass is brittle, transparent or translucent and it is available in beautiful colours. It has amorphous

structure. Glass absorbs and reflects light. It can be casted into desired shapes and can be welded by fusion. It is not affected by chemicals.

Fixing of glass panes

Glass panes are secured in place by means of putty or wooden moulds. Putty is made by mixing one part of white lead with three parts of finely powdered chalk. Boiled linseed oil is added to mixture to form a stiff paste. This paste is well kneaded and left well for twelve hours covered with a wet cloth. Sometimes little varnish is added to the paste. Thus prepared putty is known as Glazier's putty. About 185 grams putty is required for fixing and securing the glass panes, per meter of glass perimeter.

Sound Insulating Materials

It is well established that high noise conditions result in uncomfortable living, cause fatigue, inefficiency and mental strain. Prolonged exposure to noisy conditions may cause temporary deafness or nervous breakdowns. Hence, sound proofing and insulation is essential requirement of buildings. Sound proofing is absolutely essential in the cases of radio broadcasting stations, television stations, sound recording studios and film studios, etc.; whereas, sound insulation is important for office buildings, hospitals, hotels and educational institutions etc.

Acoustics and sound insulation are the functional requirement of most of buildings. Acoustic is the science of sound, which assures the optimum conditions for producing and listening to speech and music, etc. The function of sound insulation is the prevention of transmission of sound by any means, whereas sound absorption is the prevention of reflection of sound waves. Compressed straw slabs, cork slabs, slag wool, sponge rubber, wood shavings, felt, bitumen, asbestos, rock wool, acoustic plaster and breeze bricks are widely used as sound insulating materials. A layer of 12 to 25 mm thickness of these materials is usually sufficient for sound insulation.

NOTES

Damp-proofing

Dampness in the buildings occurs due to faulty design of structures, poor workmanship and faulty construction and use of poor materials of construction. Dampness results in peeling off of plaster and exposing of steel reinforcement. Hence damp proofing in buildings should essentially be done.

Source of dampness

The main sources of dampness includes orientation of the building, penetration of rain water from the exposed tops of walls, rise of ground water table, poor drainage, condensation due to atmospheric moisture and poor workman ship.

Effects of dampness

Damp buildings create unhealthy living and working conditions for occupants. Dampness promotes the growth of termites. It may promote breeding of pathogens of tuberculosis, neuralgia and chronic rheumatism. Dampness causes softening, crumbling of plaster, efflorescence on building surfaces, corrosion of metals, bleaching and flaking of paints.

Prevention of dampness

Dampness can be prevented by the following techniques and methods.

1. Use of damp-proofing course
2. Damp-proof surface treatments
3. Integral damp proofing treatments
4. Guniting or shot concrete or shotcrete
5. Cementation
6. Cavity walls

In the case of damp-proofing course (DPC), layers or membranes of water repellent materials are used. Water-proofing or damp-proofing surface treatments include filling up the pores of the materials exposed to moisture by providing a thin film of water repellent material over the surface. Some surface treatments like pointing, plastering, painting and distempering are provided to check the dampness. Most commonly used treatment to protect walls against dampness includes

application of lime-cement-plaster in 1: 1: 6 proportion. A thin film of water proofing materials may be applied on the surface of concrete.

The waterproofing agents used in surface treatments include potassium or sodium silicates, aluminium or zinc sulphates, barium hydroxide and magnesium sulphate in alternate applications. In the case of integral damp-proofing treatment certain compounds are added to concrete or mortar during mixing. These compounds include chalk, talc, fuller's earth, aluminium sulphate, calcium chloride, soap, petroleum oils and fatty acid compounds. Different damp-proofing synthetic compounds are also available in the market with various trade names, such as, Pudlo, Sika, Novoid, Ironit, Dampro, Permo and Rainex, etc. A 12-mm cement plaster in 1:2 proportion with some waterproofing compound may be laid above the plinth masonry with one or two thick coats of hot coal tar to check the dampness. Under shortcrete method of damp-proofing, a rich mixture of cement and sand in 1: 3 proportions is applied on the surfaces to restrict the dampness.

In the cementation method, cement grout; i.e., mixture of cement-sand and water is forced into the cracks under pressure to stop the dampness. Dampness can be prevented by use of cavity walls or hollow walls. In this method a cavity space of 50 mm to 80 mm is left between the walls.

Damp-proofing material

Following are some of the commonly used damp-proofing material:

1. Bitumen or Hot Asphalt: is a product of petroleum industry. It is non-crystalline solid or viscous material having adhesive properties. Bitumen is black or brown colour.

2. M. Seal: is a patented compound available in the market to stop the leakages. It is composed of two compounds. These compounds are mixed thoroughly in equal proportions to form putty. This putty is filled or pasted into the leakage cracks and spots to stop the leakages.



Fig.2.21: Damp-proofing Materials

NOTES

Characteristics of an ideal damp-proofing material

- An ideal damp-proofing material should be impervious and durable.
- It should be able to resist dead and super-imposed loads.
- It should provide lesser number of joints when laid over larger areas.
- A good damp-proofing material should not develop cracks and should not be very expensive.
- It should have proper adhesion with the surfaces.

Heat Insulating Material

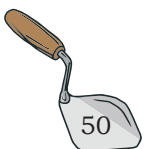
Heat insulating material are used for preventing or retarding transmission of heat or cold. Various insulating material are used for air conditioning of buildings and railway coaches. Thermal insulation in buildings results in comfortable living and working indoor conditions. Commonly used heat insulating material include rock wool, slag wool, cork board slabs mineral wool, fibre boards, saw dust, flexible blankets, wood savings, gypsum boards, AC boards, chip boards, foam glass, cork seat and cement concrete products. A good thermal insulating material should not absorb moisture and it should be able to resist the attack of insects. It should be fire proof. Some heat insulating materials are available in market on the patented trade names of Masonite, Indianite and Feathercrete, etc.

Asbestos

Asbestos cement is the combination of asbestos fibre and cement. It is commonly used for making roof sheets and pipes. Asbestos cement boards are prepared by moulding the mixture of asbestos fibre and cements under pressure.

Thermocol

Thermocol is light cellular material and acts as good electric insulator. It is strong, durable and damp-resisting material. It is also used to provide acoustic treatment in buildings and for packing purposes.



Sunglass

Sunglass is transparent plastic just like glass. It does not shatter on breaking. Styrene and Perspex are some varieties of sunglasses. It is widely used in aircraft and car industries for safety purpose. Lens is also made from sunglasses.

Abrasives

An abrasive is a hard and sharp material used to remove excess of materials by grinding or rubbing action. Emery is brownish in colour. It is cheap and widely used in the form of coarse, medium and fine grains in grinding wheels, polishing glass, emery cloth, emery paper and for making coated papers. Flint is an opaque variety of quartz. It is used for tipping glazier's diamond. Sand stone is found in India in various grain sizes and hardness. It is widely used as grinding stones in flour mills and pulp stones for shredding paper in paper mills. It is also used for polishing floor slabs. Grinding wheel is prepared by bonding abrasive powder on the cast iron wheels using suitable adhesives. Carborundum is an artificially prepared polishing abrasive. It is used for making grinding wheels, hard alloys, stones and glasses, etc. and for polishing cement concrete floors.

Adhesives

Adhesives are the substances which are used to join two or more parts to form a single unit. They are extensively used in manufacture of plywood, laminated glasses and laminated plastics, etc.



Fig.2.22: Adhesive

Linoleum

This is prepared by fixing a paste containing mixture of ground wooden cork, colouring pigment, wood flour and linseed oil on canvas or tate. Linoleums are durable, hygienic, resilient, warm, attractive and expensive floor coverings. Special linoleums are also available for wall coverings.

Rubber

Rubber is a bad conductor of heat. It can absorb shocks or impacts and can be extended by applying force.

Rubber is used for tyres of vehicles, gaskets, rubber ropes, shock absorbents, lining for reservoir and thermal insulation, etc.

Glass Wool

This is obtained by spinning out the thin fibres of glass in molten state. Glass wool is available in the forms of loose fiber, quilts, mats and rigid and semi-rigid slabs. It is used as filter in air conditioners. It is also used for heat and electric insulation.

Mica

Mica is a naturally occurring mineral made from the collection of silicate minerals, composing varying amounts of potassium, iron, aluminium, magnesium and water.

Coal Tar

Coal tar is a thick dark liquid, which is a by-product of the production of coke and coal gas from coal. These are obtained by distillation of respective materials. Crude coal tar is used for coating wooden poles, sleepers, iron poles, latrine walls and finishing nets, etc. Mineral tar is used for water proofing. Tar is also used for road making. Coal tar pitch is used for water proofing in concrete structures, flooring mastics and as base for coaltar paints.

Ferro cement

Ferro cement is highly versatile construction material which is widely being used nowadays. It is a composite

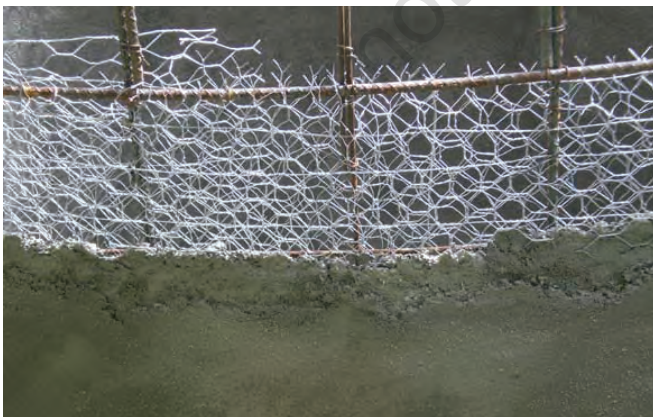


Fig.2.23: Ferro Cement work

material comprising cement-sand mortar reinforced with welded wire mesh and chicken mesh. Ferro cement products can be fabricated into any desired shape to meet the needs of the user. It does not need any expensive plant or machinery. However, ferro cement construction is labour intensive. Ordinary portland cement, sand and wire meshes having 0.5-1.0 mm diameter and 10-25 mm mesh opening have been successfully

used for many ferro cement constructions. Ferro cement

is generally used for low-cost housing, water storage tanks, economical toilet, bathroom units, grain storage silos of varying capacities and exploitation of alternate energy sources, etc.

NOTES

Practical Activity

1. Visit the local market for survey of the following materials used in the building construction.
 - (a) Bricks
 - (b) Cement
 - (c) Aggregate
 - (d) Tiles
 - (e) Paint
 - (f) Distemper
 - (g) Varnishes and polishes
 - (h) PVC fittings in plumbing
 - (i) Sand
 - (j) Glass for door and window
2. Visit the following manufacturing units
 - (a) Brick manufacturing unit
 - (b) Tile manufacturing unit
 - (c) Stone crusher
 - (d) Precast manufacturing unit
 - (e) Metal grill fabrication manufacturing workshop
 - (f) Wallpaper and flooring mat shops
 - (g) Cement manufacturing plant
 - (h) PVC pipe manufacturing unit
 - (i) Glass manufacturing unit

Check Your Progress

A. Fill in the blanks

1. Bitumen is _____ type of material.
2. Wiremesh used in ferro cement is of _____mm diameter.
3. Types of plastic are _____ and _____.
4. Plastic products are light _____ and provide sufficient _____ and corrosion _____ property.
5. Glass absorbs and reflects _____.
6. An abrasive is a _____ and sharp material used to remove _____ of materials by grinding or rubbing action.
7. Rubber is _____ conductor of heat.
8. Adhesives are the substances which are used to join _____ or more parts to form a _____ unit.
9. Mica is found in the form of thin sheets and widely used for _____ insulation.

NOTES

B. Write short notes on

1. Linolium
2. Rubber
3. Coal tar
4. Plastic
5. Adhesive
6. Glass
7. PVC
8. Damp-proofing material

C. Multiple choice questions

1. Which thermoplastic resin provides light and tough sheets?
(a) Perspex (b) Alkathene
(c) PVC (d) Polyethylene
2. Mica can be used for _____.
(a) thermal insulation (b) sound insulation
(c) electrical insulation (d) None of these
3. Which of these is a bad conductor of heat?
(a) Mica (b) Rubber
(c) Glass wool (d) Linoleum
4. Which among these is a good electric insulator?
(a) Thermocol (b) Sunglass
(c) Asbestos (d) PVC